

- 1 1. A method for mapping a location on a surface of a three-dimensional virtual
2 object to a corresponding location on a two-dimensional texture, the method comprising
3 the steps of:
 - 4 (a) selecting a region on a surface of a three-dimensional virtual object;
 - 5 (b) creating a first mesh comprising points corresponding to points within the
6 selected region;
 - 7 (c) creating a second mesh comprising points corresponding to points of the
8 first mesh;
 - 9 (d) adjusting the second mesh to improve a quality metric associated with an
10 arrangement of points of the second mesh;
 - 11 (e) relating the adjusted second mesh to a two-dimensional texture; and
 - 12 (f) mapping a location in the selected region to a corresponding location in
13 the texture.
- 1 2. The method of claim 1, wherein step (d) further comprises defining the quality
2 metric using the first mesh.
- 1 3. The method of claim 1, wherein the first mesh and the second mesh have an
2 identical number of points.
- 1 4. The method of claim 1, wherein the three-dimensional virtual object is
2 represented in a first coordinate space and the two-dimensional texture is represented in a
3 second coordinate space.
- 1 5. The method of claim 4, further comprising the steps of:

- 2 (g) defining a first geometric representation relating a first parameter space to
3 the first coordinate space; and
- 4 (h) defining a second geometric representation relating the first parameter
5 space to the second coordinate space.
- 1 6. The method of claim 5, wherein at least one of the first geometric representation
2 and the second geometric representation is selected from the group consisting of a
3 NURBS patch, a Bezier patch, a Cardinal spline patch, a Gregory patch, a bilinear patch,
4 a bicubic patch, a polygon mesh, and a triangle mesh.
- 1 7. The method of claim 5, wherein at least one of the first geometric representation
2 and the second geometric representation is interpolable.
- 1 8. The method of claim 5, wherein the mapping of step (f) comprises determining
2 parameters of the first parameter space corresponding to the location in the selected
3 region.
- 1 9. The method of claim 1, wherein the region in step (a) is a contiguous user-defined
2 region.
- 1 10. The method of claim 1, wherein step (a) comprises selecting the region using a
2 curve loop drawn on the surface of the virtual object by a user.
- 1 11. The method of claim 10, wherein the curve loop comprises a plurality of curves.
- 1 12. The method of claim 10, wherein the curve loop comprises four curves.
- 1 13. The method of claim 1, wherein the first mesh comprises substantially uniformly-
2 spaced points.
- 1 14. The method of claim 1, wherein the second mesh consists of points lying within a
2 plane.

- 1 15. The method of claim 1, wherein points of the second mesh are substantially
2 uniformly spaced prior to the adjusting of step (d).
- 1 16. The method of claim 1, wherein step (d) comprises modeling at least a plurality of
2 the points of the second mesh as connected by springs.
- 1 17. The method of claim 16, wherein step (d) comprises adjusting the second mesh to
2 reduce an energy associated with the springs.
- 1 18. The method of claim 16, wherein step (d) comprises adjusting the second mesh in
2 a step-wise manner to substantially minimize an energy associated with the springs.
- 1 19. The method of claim 16, wherein step (d) comprises modeling an interior point of
2 the second mesh as connected to eight neighboring mesh points by eight springs.
- 1 20. The method of claim 16, wherein the springs comprise at least one linear spring.
- 1 21. The method of claim 16, wherein step (d) further comprises modeling at least one
2 point using at least one torsional spring.
- 1 22. The method of claim 16, wherein step (d) comprises adjusting edge points of the
2 second mesh.
- 1 23. The method of claim 16, wherein step (d) comprises using distances between
2 neighboring points of the first mesh as set lengths for corresponding springs.
- 1 24. The method of claim 23, wherein the distances between neighboring points of the
2 first mesh are shortest-path geodesic distances.
- 1 25. The method of claim 23, wherein the distances between neighboring points of the
2 first mesh are approximate.

1 26. The method of claim 1, wherein step (b) comprises creating the first mesh from a
2 representation of the surface of the virtual object using at least one of a Delaunay
3 triangulation technique and a Voronoi diagram.

1 27. The method of claim 1, wherein step (e) comprises relating the adjusted second
2 mesh to the two-dimensional texture using a transformation matrix.

1 28. The method of claim 27, wherein the transformation matrix accounts for at least
2 one of a translation of the texture, a rotation of the texture, and a scaling of the texture.

1 29. A method for mapping a location on a surface of a virtual object to a
2 corresponding location on a texture, the method comprising the steps of:

3 (a) selecting a region on a surface of a virtual object represented in a first
4 coordinate space;

5 (b) defining a first patch corresponding to the selected region;

6 (c) tessellating the first patch to create a first mesh;

7 (d) creating a second mesh comprising points corresponding to points of the
8 first mesh;

9 (e) adjusting the second mesh to improve a quality metric associated with an
10 arrangement of points of the second mesh;

11 (f) defining a second patch using the second mesh;

12 (g) superimposing a texture onto the second patch, wherein the texture is
13 represented in a second coordinate space; and

14 (h) mapping a location on the surface of the virtual object to a corresponding
15 location on the texture.

- 1 30. The method of claim 29, wherein step (e) further comprises defining the quality
2 metric using the first mesh.
- 1 31. The method of claim 29, wherein the texture comprises a tiled pattern, and
2 wherein no boundary of a tile of the tiled pattern is constrained to align with a boundary
3 of the region.
- 1 32. The method of claim 29, wherein the texture is an image, and wherein no
2 boundary of the image is constrained to align with a boundary of the region.
- 1 33. The method of claim 29, wherein the first coordinate space is three-dimensional
2 and the second coordinate space is two-dimensional.
- 1 34. The method of claim 33, wherein the first patch relates a first parameter space to
2 the first coordinate space, and wherein the second patch relates the first parameter space
3 to the second coordinate space.
- 1 35. The method of claim 34, wherein the first parameter space is a (u,v) parameter
2 space.
- 1 36. The method of claim 34, wherein the second patch relates the first parameter
2 space to the second coordinate space using a linear transformation between the first
3 parameter space and a second parameter space.
- 1 37. The method of claim 34, wherein the second patch directly relates the first
2 parameter space to the second coordinate space.
- 1 38. The method of claim 29, wherein the region in step (a) is a contiguous user-
2 defined region.
- 1 39. The method of claim 29, wherein at least one of the first patch and the second
2 patch is a NURBS patch.

1 40. The method of claim 29, wherein at least one of the first patch and the second
2 patch is a member selected from the group consisting of a Bezier patch, a Cardinal spline
3 patch, a Gregory patch, a bilinear patch, and a bicubic patch.

1 41. The method of claim 29, wherein at least one of the first patch and the second
2 patch is interpolable.

1 42. The method of claim 29, wherein step (b) comprises the substeps of:

- 2 (i) generating an initial grid comprising grid points;
- 3 (ii) projecting at least a plurality of the grid points onto the surface of the
4 virtual object;
- 5 (iii) modeling at least a plurality of the grid points as connected by springs;
- 6 (iv) adjusting at least a plurality of the grid points to decrease an energy
7 associated with the springs; and
- 8 (v) defining a NURBS patch using at least a plurality of the grid points.

1 43. The method of claim 42, wherein step (b) further comprises the substep of:

- 2 (vi) repeating the projecting of substep (ii) and the adjusting of substep (iv)
3 until the energy associated with the springs is substantially minimized.

1 44. The method of claim 42, wherein substep (iii) comprises modeling an interior grid
2 point as connected to four neighboring grid points by four springs.

1 45. The method of claim 42, wherein substep (iv) comprises constraining grid points
2 to lie on the surface of the object.

1 46. The method of claim 42, wherein each of the springs in substep (iii) has an
2 identical set length.

- 1 47. The method of claim 42, wherein substep (v) comprises performing a least
2 squares fit using the adjusted grid points.
- 1 48. The method of claim 29, wherein step (e) comprises modeling at least a plurality
2 of the points of the second mesh as connected by springs having set lengths based on
3 distances between corresponding points of the first mesh.
- 1 49. The method of claim 48, wherein step (e) comprises adjusting the second mesh in
2 a step-wise manner to substantially minimize an energy associated with the springs.
- 1 50. The method of claim 48, wherein step (e) comprises modeling an interior point of
2 the second mesh as connected to eight neighboring grid points by eight springs.
- 1 51. The method of claim 29, wherein the superimposing of step (g) comprises using a
2 transformation matrix.
- 1 52. The method of claim 51, wherein the transformation matrix accounts for at least
2 one of a translation of the texture, a rotation of the texture, and a scaling of the texture.
- 1 53. The method of claim 29, wherein step (h) further comprises assigning to the
2 location on the surface of the virtual object a graphical value associated with the
3 corresponding location on the texture.
- 1 54. The method of claim 53, wherein the graphical value is a color value.
- 1 55. The method of claim 53, wherein the graphical value represents an adjustment
2 along a normal to the surface of the virtual object.
- 1 56. A method for wrapping a texture onto a surface of a three-dimensional virtual
2 object, the method comprising the steps of:
- 3 (a) selecting an arbitrarily-shaped user-defined region of a surface of a three-
4 dimensional virtual object; and

- 5 (b) for each of a plurality of locations in the region:
- 6 (i) mapping the location in the selected region to a corresponding
- 7 location in a texture; and
- 8 (ii) assigning to the location in the selected region a graphical value
- 9 associated with the location in the texture.
- 1 57. The method of claim 56, further comprising the step of:
- 2 (c) graphically rendering the virtual object.
- 1 58. The method of claim 57, further comprising the step of:
- 2 (d) modifying a voxel representation of the virtual object according to the
- 3 graphical values assigned in step (b).
- 1 59. The method of claim 56, wherein the texture comprises a tiled pattern.
- 1 60. The method of claim 59, wherein no boundary of a tile of the tiled pattern is
- 2 constrained to align with a boundary of the user-defined region.
- 1 61. The method of claim 59, further comprising the step of:
- 2 (c) graphically rendering the virtual object with the tiled pattern applied
- 3 within the user-defined region.
- 1 62. The method of claim 56, wherein the graphical value is a color value.
- 1 63. The method of claim 56, wherein the texture comprises an embossing pattern and
- 2 wherein the graphical value represents an adjustment along a normal to the surface of the
- 3 virtual object.
- 1 64. The method of claim 63, further comprising the step of:
- 2 (c) graphically rendering the virtual object with the embossing pattern
- 3 applied within the user-defined region.